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DEPARTMENT OF AGRICULTURE AND FISHERIES
FOR SCOTLAND

Marine Research
1962 No. 3

The Food of the Norway Lobster

Nephrops norvegicus (L.)

By H. J. THOMAS, B.Sc., Ph.D., and C. DAVIDSON

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Nephrops norvegicus (L.)

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Marine Laboratory, Aberdeen—April, 1962

EDINBURGH: HER MAJESTY'S STATIONERY OFFICE
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The Food of the Norway Lobster

INTRODUCTION

The Norway lobster over the past decade has assumed considerable commercial importance in otland and in view of this a programme of research devoted to this species was initiated.

The biology of the species is incompletely known. The food of the Norway lobster is referred to by glund (1942) who states that the stomach contents are for the most part so finely ground that nothing dentifiable except fragments of mussel-shell and chitinous parts of small crustacea. The diet is probably y varied.

The following investigation of the food of the Norway lobster, carried out during 1960-61, was part a wider programme devoted to this species which was undertaken at the Marine Laboratory, erdeen.

MATERIAL AND METHODS

Norway lobsters taken by research vessel otter trawl with small mesh attachment were preserved 4% formalin. The following samples were examined:

females, carapace length 17-51 mm,

1960	July-August	Firth of Forth (No. examined 90)
		Moray Firth (60)
		Minch (40)
		Firth of Clyde (110)
	October	South-east Scotland (57);

females, carapace length 15-46 mm,

1961	March	Minch (14)
		Firth of Clyde (50);

males, carapace length 48-63 mm,

1961	July	Moray Firth (10)
		Minch (33);

random sample for sex and size,

1961	September	Firth of Forth (91 males, 38 females);

females, carapace length 22-40 mm,

1961	November	Minch (77);

both sexes, carapace length 20-46 mm,

1961	November	Firth of Clyde (7 males, 29 females).

Examination of the food organisms was confined to those occurring in the foregut (stomach). The rway lobster masticates its food to a considerable extent before ingestion and so, as stated by Höglund 42), identification is often difficult. A variable proportion of the foregut contents consists of particulate terial which is unidentifiable. Nevertheless much of the food can be classified according to the phylum d about half according to the family and often to the genus.

Owing to the small particle size and the side effects of digestion (secretion of digestive juices, ac- mulation of indigestible material etc.) estimation of the weight or volume of stomach contents was not sidered worthwhile. The following records of stomach contents are related only to the frequency of currence expressed as the percentage of those foreguts, excluding empties, which were found to contain

the particular food organism or class of food. Very few were empty. In addition some measurements the particle size were made where species occurring in the foregut contents were relatively unmutilate The nomenclature is that of the Plymouth Marine Fauna (Marine Biological Association, 1957). T publications used in identification of specimens are quoted in the list of references.

In addition to examination of the foregut contents, observations on the feeding habits of the Norwa lobster were carried out in the aquarium to ascertain how far the behaviour characteristics of the anim influenced the selection of food organisms found in foreguts of Norway lobsters taken from their natur environment.

FEEDING HABITS

In the aquarium the Norway lobster seeks cover in crevices, between rocks or in excavations of t bottom. Unless very hungry it will feed only in very subdued light. Markings on the soft bottom sho that the animal forages in dull light. The Norway lobster is capable of catching active prey by using i great claws and walking legs in a grasping fashion. Alternatively it will walk on a soft bottom and whe over passive food material, lying on or within the mud or sand, will close its walking legs round the foo Small food particles and pieces of stone or shell carrying organic encrustations are picked up. Particl are held by the claw(s) of the first walking leg(s), or if necessary owing to size or activity by mo posterior walking legs which clasp the food. The food is conveyed to the mouth by the anterior walkir leg(s) with the assistance of the maxillipeds, which retain and hold large items between the mandibl and masticatory appendages. Threadlike food such as polychaetes is ingested lengthwise and lengths up to 6 cm of such food may be taken whole into the stomach. The maximum diameter of hard-shell food passing from the mandibles into the mouth, however, is of the order of 5 mm.

The animal was never seen to cope with macerated soft food. It appears that there is a minimu size of particle (diameter about 1 mm) which can be manipulated and passed to the mouth. If the aquarium observations apply in the natural environment, the Norway lobster, which is invariably take on a bottom of sticky mud, forages over this mud for its food and is not directly a detritus feeder. T mud which is frequently found in the hind gut is a secondary result of its feeding, being derived indirect from prey. This may also apply in part to Foraminifera. The food material, limited at its lower siz limit to organisms which can be manipulated by the appendages, is restricted at its upper limit to o ganisms which can be held and masticated prior to entry to the gut. On the other hand the Norwa lobster has been observed to take up particles of stone and work these round with the masticating appe dages. Such actions could enable the animal to graze off small stones, shells, etc., organisms such hydroids, polyzoa and perhaps algae which, owing to their small size, may themselves otherwise not available.

STOMACH CONTENTS

The relative occurrence of the different animal groups, excluding Foraminifera (see p. 11), found the foreguts of female Norway lobsters of random size taken during July and August 1960 in the Fir of Clyde, the Minch, the Moray Firth and the Firth of Forth, together with the relative number of emp foreguts, are shown in Figure 1. Polychaeta, Crustacea and Mollusca form the bulk of the food in a areas. The relative proportions of these groups are not greatly different within the four areas examine The occurrence of Echinodermata on the contrary varies to a much greater extent, being most freque in the Minch where 65% of foreguts contained echinoderms. The corresponding percentages in oth areas were: Firth of Clyde 46%, the Moray Firth 42%, the Firth of Forth 23%. In the Minch, polychaete crustaceans and molluscs occurred in over 80% of the stomachs. The Norway lobster appears to be very varied feeder taking indiscriminately the organisms available to it. In consequence individu foreguts often contain a considerable variety of food. Of 677 foreguts containing food from the five ma food types (Polychaeta, Crustacea, Mollusca, Echinodermata and miscellaneous types) 82 contained a five in combination whilst only 64 were restricted to a single type of food (Table I). The majority contain

ree food types and of these the commonest combination, which occurred in 87 foreguts, was of poly-
aetes, crustaceans and molluscs. Forty-nine foreguts contained crustaceans, molluscs and echinoderms,
e next commonest combination. In general there appears to be little selection of food, which comprises
ganisms, occurring either on or just within the sea floor, and of a size the Norway lobster is capable of
tching, handling and masticating.

TABLE I

THE NUMBER OF FOREGUTS, PER SAMPLE AND OVERALL, CONTAINING FOOD IDENTIFIABLE AS POLYCHAETA (P), CRUSTACEA (C), MOLLUSCA (M), ECHINODERMATA (E) AND OTHER TYPES, AND THE NUMBER OF FOREGUTS CONTAINING COMBINATIONS OF THE MAIN FOOD TYPES

Year	Area	No. of stomachs with identifiable organisms	No. of stomachs containing combinations of different food types					No. of stomachs containing 3 or 4 of the main food types in combination				
			1 type	2 types	3 types	4 types	All 5 types	PCM	PCE	PME	CME	PCME
960	Firth of Clyde	108	13	34	33	25	3	17	2	3	11	5
	Minch	39	—	2	9	14	14	7	1	4	3	16
	Moray Firth	59	2	6	25	14	12	12	4	3	3	13
	Firth of Forth	84	12	28	26	15	3	21	3	2	—	9
	South-east Scotland	55	9	21	20	4	1	4	6	—	11	4
961	Firth of Clyde Mar.	49	6	15	19	6	3	4	—	3	—	3
	Firth of Clyde Nov.	32	2	12	8	8	2	1	1	—	5	3
	Minch Mar.	11	2	3	1	5	—	—	—	2	—	—
	Minch July	33	—	3	9	20	1	2	7	1	2	18
	Minch Nov.	77	1	1	15	34	26	11	1	17	4	29
	Moray Firth	8	2	4	1	1	—	—	—	1	—	1
	Firth of Forth	122	15	26	38	26	17	8	8	6	10	28
	Overall	677	64	155	204	172	82	87	33	41	49	129

The relative occurrences of the different animal types in the food of male Norway lobsters of 48-62 mm
rapace length taken in the Minch and the Moray Firth in July 1961 agree closely with the correspond-
g data for females from the same areas at the same season in 1960 (Fig. 2). There would, therefore,
pear to be no marked difference of feeding between the sexes or the different size-groups of Norway
bsters, whilst year to year variations probably depend only on the variation in the relative abundance
the available food organisms.

The above interpretation is substantiated by the data relating to both male and female Norway
bsters of random size distribution taken in the Firth of Forth at the end of September 1961 (Figure 3A).
ie presence of the animal groups in the foregut contents of males and females correspond closely in the
o sexes. However, the percentage containing echinoderms was very much higher in September 1961
an in August 1960 whilst the 'other' category in 1961 reached 24% as compared with 4% in 1960.
iis difference mainly relates to hydroids and polyzoans. Polychaetes were markedly more abundant in
igust 1960 than in September 1961. It is reasonable to suppose that the scarcity of available Polychaeta
responsible for the increased percentage in 1961 of Echinodermata and especially of Coelenterata
d Polyzoa, which the Norway lobster finds more difficult to handle.

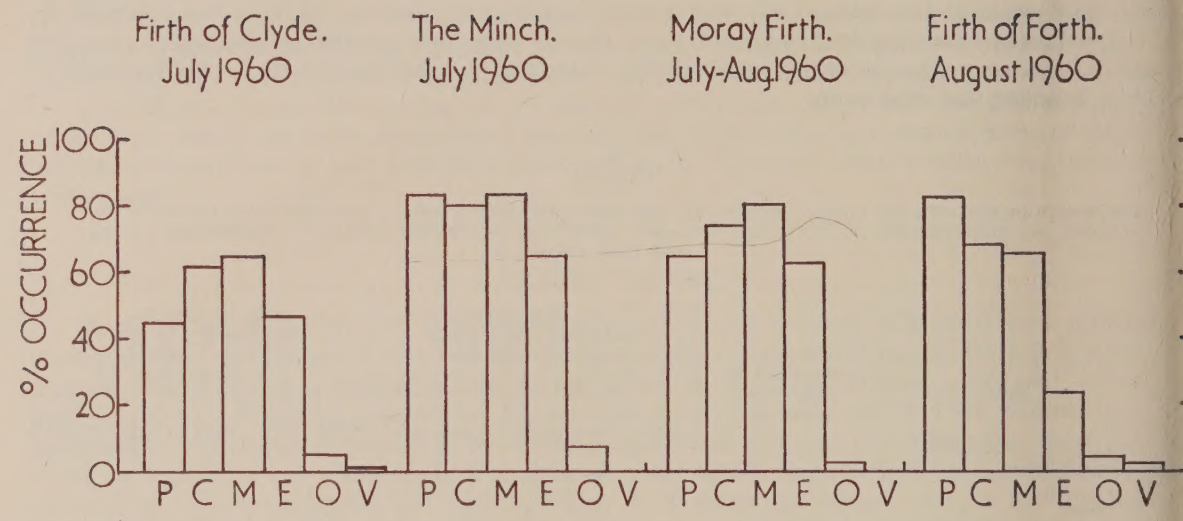

Fig. 1 Percentages of foreguts examined containing polychaetes (P), crustaceans (C), molluscs (M), echinoderms (E) and others (O). Voids are indicated by V. Samples of female Norway lobsters taken during July-August 1960 from the Firth of Clyde, the Minch, the Moray Firth and the Firth of Forth respectively.

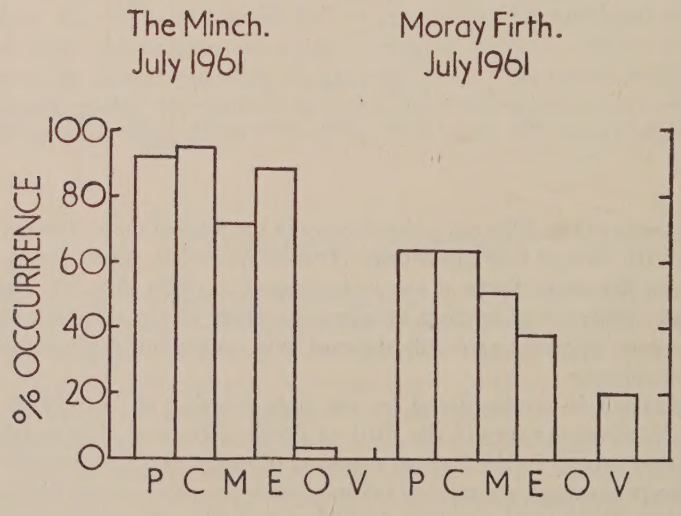

Fig. 2 Percentages of foreguts containing the various food types; male Norway lobsters of carapace lengths 48-63 mm, taken during July 1961 in the Minch and in the Moray Firth. (Key as in Fig. 1)

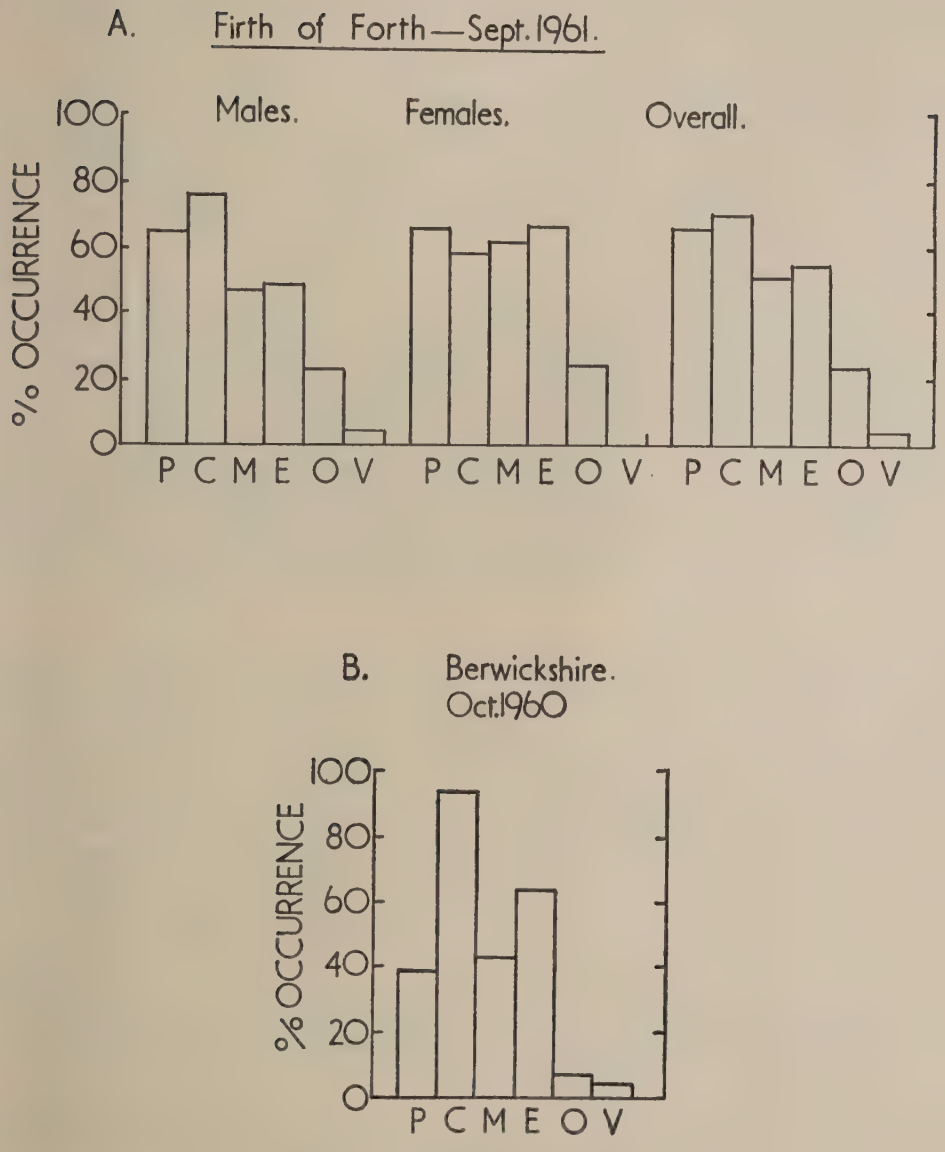

Fig. 3 Percentages of foreguts containing the various food types; polychaetes (P), crustaceans (C), molluscs (M), echinoderms (E), others (O); V indicates voids; (A) male and female Norway lobsters, respectively and collectively, taken during September 1961 from the Firth of Forth; (B) female Norway lobsters taken during October 1960 off Berwickshire.

The relative occurrence of the various animal groups in the food of female Norway lobsters taken off Berwickshire, south-east Scotland, in October 1960 is given in Figure 3B. In this sample Crustacea in the form of portunids and crangonids occurred in 93% of the stomachs. The proportion of echinoderms was also high (64%).

The relative occurrence of the different animal groups in the foreguts of female Norway lobsters, 15-46 mm carapace length, taken in the Firth of Clyde and the Minch in March and November 1961 is shown in Fig. 4. The percentages for November in each area are broadly similar to the corresponding percentages for July-August (Fig. 1). The small sample (14 foreguts of which three were void) from the Minch in March suggests a lower level of feeding intensity which may in part be due to the fact that this sample included 10 berried females. The general foregut content is, however, not markedly different from that at other seasons. In the Clyde on the other hand a marked increase in the occurrence of polychaetes and fish in March 1961, as compared with June and November, was accompanied by a decrease in the occurrence of Crustacea and Echinodermata. Post-larval *Ammotrypane aulogaster* were responsible for the increase in the Polychaeta (see below). These results suggest that seasonal differences occur in the feeding of Norway lobsters, owing to the temporary abundance of certain food organisms following settlement.

Fig. 4 Percentages of foreguts containing the various food types; polychaetes (P), crustaceans (C), molluscs (M), echinoderms (E), others (O) and voids (V); female Norway lobsters of carapace length 15-46 mm taken during March and November 1961 in the Firth of Clyde and in the Minch.

Combining all the data from the 706 foreguts examined, 2% were empty and in the remainder Polychaeta occurred in 66%, Crustacea in 67%, Mollusca in 64%, Echinodermata in 50% and Foraminifera in 41%. Fish occurred in 13% of the foreguts and polyzoans and hydroids each in 3%.

The frequencies of organisms occurring in the foreguts are given in Table II.

Polychaeta

Of the foreguts containing solid matter, polychaetes were present in 66%. Sedentary polychaetes constituted the majority of the forms, being present in 30% of the foreguts, the commonest being *Pectinaria* species (14% of foreguts). Where these consisted of whole animals they were small forms of about 3 to 5 mm in length. Otherwise the genus was identified by parts of the tube. In the Firth of Forth, August 1960, 37% of the foreguts contained *Pectinaria* sp., frequently several small whole specimens per foregut. This was the principal polychaete food species identified in all areas except the Moray Firth. The Oweniidae (5% of foreguts) were also represented in most areas, particularly *Owenia fusiformis*.

Myriochele sp. was common in the foreguts from the Firth of Clyde but was not found elsewhere. Similarly, although not recorded from any other sample, *Ammotrypane aulogaster* was found in 67% of the foreguts from the Firth of Clyde in March 1961 (Table II). The specimens consisted wholly of juveniles originating from a recent dense settlement of larvae. Amongst errant polychaetes the Glyceridae (9% of foreguts) were eaten in most areas, their occurrence being more marked in 1961 than in 1960 (one foregut contained a part specimen 58 mm long; another the anterior 35 mm of a large glycerid), whilst Nereidae were represented in 5% of the foreguts.

Whilst certain foreguts contained whole or large parts of polychaetes, the majority of this group found in the stomachs were represented by fragments identifiable only by jaws, setae, tubes, etc.

Crustacea

Crustacea were the most frequently occurring type of identifiable foregut contents in all areas and at all seasons. Crustacean remains were found in 67% of the stomachs. Reptant decapods (21% of foreguts) were found in all areas at all seasons, the commonest form being *Portunus* sp. These were of larval or immediate post-larval stages. Whole specimens were relatively frequent and one or more occurred in certain stomachs. Their maximum length was about 8 mm. Natant decapods (6% of foreguts), mainly *Crangon* sp., were represented by early settlement forms, small forms or broken pieces of larger specimens. Ostracods (15% of foreguts) were also of widespread and frequent occurrence. Also widespread were amphipods (7% of foreguts), mainly Ampeliscidae, either as small whole animals or broken-up larger specimens. Cumacea (6% of foreguts), complete animals up to 8 mm in length, were widespread, whilst Copepoda (5%), mainly harpacticoids, were commonly eaten in the Firth of Clyde.

Mollusca

Molluscs were present in all areas at all seasons and overall occurred in 64% of the foreguts. All the main families were represented including Cephalopoda. The most frequently occurring group was the Lamellibranchia (59% of foreguts) amongst which *Nucula* sp. (20%) and *Abra* sp. (18%), consisting of small but whole specimens, up to 3 mm in diameter, or broken-up larger forms, were of most frequent occurrence. *Abra* sp. were found in all areas at all seasons but *Nucula* sp. was absent from the Nephrops examined from the Firth of Forth. The whole specimens showed markings in the shell where the animals had been punctured by the claws of the first pair of walking legs. Frequently several specimens of the one species were found in individual foreguts. Veneridae (8%) were also eaten over a wide area. Small gastropods (8%) were found in most areas, being represented in the main by small post-larval specimens.

Echinodermata

Although of less frequent occurrence than polychaetes, crustaceans and molluscs, echinoderms were found in 50% of the Norway lobsters from all areas and at all seasons. The most common class was the echinoids (28%), represented by broken tests. Those identifiable were irregular urchins. Also of widespread and frequent occurrence were ophiuroids (16%), identifiable by fragments of the arms or discs. The size of the discs ranged up to a maximum of 3 mm.

Pisces

Fish (13% of foreguts) were of fairly widespread occurrence. The group was represented by larvae or by bones and scales from small post-larval forms.

Foraminifera

Foraminifera were present in 41% of the foreguts in most areas. The feeding habits of the Norway lobster suggest that microscopic Foraminifera may occur in the foreguts of Norway lobsters as secondary food organisms, having been derived from the alimentary tracts of larger animals, such as echinoderms eaten by the Norway lobster. However, it is possible that large Foraminifera, of about 1 mm diameter, are preyed upon directly by the Norway lobster.

TABLE II

THE NUMBER OF FOREGUTS EXAMINED, THE NUMBER CONTAINING NO FOOD AND THE FREQUENCY OF OCCURRENCE OF THE DIFFERENT FOOD TYPES PER 100 FOREGUTS CONTAINING FOOD IN EACH OF 12 SAMPLES AND OVERALL

	1960					1961							
	July	July	July—Aug.	Aug.	Oct.	Mar.	Mar.	July	July	Sept.	Nov.	Nov.	Overall
No. examined	110	40	60	90	57	50	14	33	10	129	36	77	706
No. empty	1	0	0	2	2	1	3	0	2	4	2	0	17
Area	F. of Clyde	Minch	Moray Firth	F. of Forth	S.E.	F. of Clyde	Minch	Minch	Moray Firth	F. of Forth	F. of Clyde	Minch	
POLYCHAETA (total)	44	83	65	82	38	88	36	91	63	66	26	88	66
Errantia (unident.)	6	13	15	8	5	2	9	12	—	3	—	3	6
Aphroditidae	1	5	—	—	4	—	—	3	—	1	—	—	1
Aphrodite aculeata	—	—	—	—	2	—	—	3	—	—	—	—	+
Polynoinae	—	—	—	—	2	—	—	—	—	—	—	—	+
Sigalioninae	—	—	—	—	—	—	—	—	—	1	—	—	+
Nereidae	—	—	—	1	2	27	—	—	—	10	—	—	4
Nephthydidae	1	8	—	1	2	2	—	—	13	3	8	—	2
Glyceridae	3	—	10	12	4	10	18	27	50	14	6	3	9
Goniada sp.	—	—	2	—	2	—	—	—	—	2	—	—	1
G. norvegica	—	—	—	—	—	—	—	6	—	—	—	—	+
G. maculata	—	—	—	—	—	—	9	—	—	—	—	—	+
Eunicidae	2	—	—	—	—	4	—	3	—	—	—	3	1
Lumbriconereis sp.	2	—	—	—	—	2	—	3	—	—	—	1	1
Sedentaria (unident.)	15	68	38	36	11	24	27	45	13	11	12	74	30
Spionidae	1	—	2	3	—	—	—	—	—	—	—	—	1
Chlorhaemidae	—	—	—	1	—	—	—	—	—	2	—	1	1
Ammotrypane aulogaster	—	—	—	—	—	67	—	—	—	—	—	—	5
Capitellidae	—	3	—	—	—	2	—	—	—	1	—	—	+
Oweniidae	16	3	2	1	—	—	—	9	—	2	—	10	5
Owenia fusiformis	1	3	2	1	—	—	—	9	—	2	—	10	3
Myriochele sp.	15	—	—	—	—	—	—	—	—	—	—	—	2
Pectinaria sp.	8	10	8	37	2	—	—	24	—	24	—	5	14
Hydroides norvegica	—	—	—	—	—	—	—	—	—	1	—	—	+
Unident. polychaetes	17	5	20	12	11	2	—	27	—	14	3	9	12
CRUSTACEA (total)	61	80	74	68	93	35	54	94	63	70	44	62	67
Ostracoda	28	13	33	1	—	20	9	3	—	9	24	22	15
Philomedes sp.	—	—	—	—	—	—	—	—	—	—	—	1	+
Copepoda	22	—	3	1	—	6	—	—	—	1	15	—	5
Harpacticoida	22	—	—	—	—	6	—	—	—	1	15	—	5
Nebalia bipes	—	—	—	2	—	—	—	—	—	—	—	—	+
Cumacea	—	10	15	6	—	—	—	21	—	2	—	16	6
Leuconidae	—	—	—	—	—	—	—	—	—	—	—	9	1
Campylapsis costata	—	—	—	—	—	—	—	—	—	—	—	1	+
Tanaidae	—	—	—	—	—	—	—	—	—	1	—	6	1
Isopoda	—	5	—	—	—	—	—	3	—	—	—	3	1
Cirolana borealis	—	—	—	—	—	—	—	3	—	—	—	—	+
Amphipoda	4	—	5	11	5	—	—	15	—	10	—	18	7
Ampeliscidae	—	—	—	7	2	—	—	9	—	6	—	6	4
Phoxocephalidae	—	—	—	—	—	—	—	—	—	—	—	1	+
Amphilochidae	—	—	—	—	—	—	—	—	—	—	—	1	+
Oedicerotidae	—	—	—	—	—	—	—	—	—	—	—	1	+
Lembos longipes	1	—	—	—	—	—	—	—	—	—	—	—	+
Caprellidae	—	—	—	—	—	—	—	—	—	2	—	—	+
Mysidae	—	—	—	—	4	—	—	—	—	—	—	—	+
Natant decapoda	1	—	2	2	36	—	18	15	—	5	—	1	5
Processa sp.	—	—	—	—	—	—	—	—	—	1	—	—	+
Crangon sp.	—	—	2	1	30	—	—	—	—	2	—	—	3
Reptant decapoda	15	8	35	35	54	—	9	51	50	10	6	9	21
Nephrops norvegicus	—	—	—	—	—	—	—	3	—	—	—	—	+
Galatheidae	1	3	—	1	—	—	—	—	—	—	—	1	1
Porcellana sp.	1	—	—	1	—	—	—	—	—	—	—	—	+
Thallassinidea	—	—	—	—	—	—	—	3	—	—	—	—	+
Paguridae	1	—	5	2	4	—	—	6	—	2	—	—	2
Anapagurus laevis	—	—	—	—	—	—	—	3	—	—	—	—	+
Portunus sp.	3	—	17	18	30	—	—	—	—	2	—	—	4
Corystes cassivelaunus	—	—	—	2	—	—	—	—	—	—	—	—	+
Unidentified crustacea	28	75	45	28	60	12	18	33	13	53	15	14	35

TABLE II—*contd.*

	1960					1961							
	July	July	July—Aug.	Aug.	Oct.	Mar.	Mar.	July	July	Sept.	Nov.	Nov.	Overall
No. examined	110	40	60	90	57	50	14	33	10	129	36	77	706
No. empty	1	0	0	2	2	1	3	0	2	4	2	0	17
Area	F. of Clyde	Minch	Moray Firth	F. of Forth	S.E.	F. of Clyde	Minch	Minch	Moray Firth	F. of Forth	F. of Clyde	Minch	
MOLLUSCA (total)	64	83	80	65	42	51	45	70	50	51	59	91	64
Solenogastres	—	—	—	—	—	—	—	3	—	4	—	6	1
Gastropoda	—	28	10	3	9	2	—	6	—	18	—	4	8
Bullomorpha	—	3	—	2	—	2	—	—	—	6	—	1	2
Turbonilla sp.	—	—	—	1	—	—	—	—	—	—	—	—	+
Scaphandridae	—	—	—	—	—	—	—	—	—	1	—	—	+
Philinidae	—	—	—	1	—	—	—	—	—	6	—	—	1
Scaphopoda	—	35	2	—	—	—	9	—	—	1	—	45	8
Lamellibranchia	62	73	80	64	34	43	45	67	50	40	59	87	59
Nucula sp.	30	53	25	—	—	6	27	12	—	—	18	69	20
Pectenidae	—	—	—	1	—	—	—	—	—	—	—	1	+
Cyprina islandica	—	—	2	—	—	—	—	—	—	—	—	—	+
Mysella sp.	1	—	—	—	—	—	—	—	—	—	—	—	+
Cardium sp.	1	—	—	—	7	—	—	6	—	2	3	16	3
Veneridae	2	3	13	8	2	2	9	6	—	10	—	1	8
Abra sp.	18	38	37	28	2	2	9	9	37	6	8	25	18
Tellinidae	—	—	—	—	—	—	9	—	—	—	6	—	+
Solenidae	—	—	2	—	—	—	—	—	—	1	3	—	+
Corbula gibba	—	—	—	—	—	—	—	—	—	—	—	1	+
Hiatella sp.	2	—	—	—	—	—	—	—	—	—	—	—	+
Mya sp.	—	—	—	1	—	—	—	—	—	—	—	—	+
Cephalopoda	2	—	—	1	5	6	—	—	—	1	—	—	2
Unidentified mollusca	—	—	—	—	—	—	—	—	—	2	—	—	+
ECHINODERMATA (total)	46	65	42	23	64	18	36	88	38	54	65	71	50
Ophiuroidea	—	37	13	6	21	2	18	51	—	18	—	32	16
Amphiura sp.	—	—	—	—	—	—	—	9	—	2	—	—	1
A. chiajei	—	—	—	—	—	—	—	3	—	1	—	—	+
A. filiformis	—	—	—	—	—	—	—	9	—	—	—	—	1
Ophiura sp.	—	8	8	1	—	—	—	—	—	—	—	—	1
Echinoidea	30	13	28	—	—	12	27	33	13	37	59	65	28
Irregular Urchins	30	—	—	—	—	—	9	15	13	22	32	3	12
Holothurioidea	—	—	—	—	—	—	—	—	—	1	—	—	+
Echinoderm (unident.)	15	28	12	18	52	6	9	33	25	14	6	3	17
PISCES	2	3	2	5	7	67	9	—	—	16	24	25	13
FORAMINIFERA	52	78	73	16	—	38	55	12	—	14	67	90	41
COELENTERATA (Hydroid)	—	—	—	—	—	—	—	—	—	17	15	4	3
NEMERTINI	—	3	—	—	—	—	—	—	—	—	—	—	+
ECHIUROIDEA	—	—	—	—	—	—	—	—	—	2	—	—	+
INSECTA	—	—	—	1	—	—	—	—	—	—	—	—	+
PHORONIDEA	—	—	—	—	—	—	—	—	—	2	—	—	1
POLYZOA	—	3	—	—	—	—	—	—	—	19	—	—	3
PARTICULATE MATTER	89	93	93	74	80	92	55	3	—	11	87	92	68

Miscellaneous

Coelenterates were present in only 3% of the stomachs from all areas but in 1961 they occurred in 17% of foreguts from the Firth of Forth. They consisted exclusively of hydroids. Polyzoa also appeared frequently in this same sampling (19% of foreguts) although not occurring generally elsewhere. Phoronidea and Echiuroidea were also found to have been eaten in this sampling which was undertaken in late September. The occurrence of these forms, mainly in the autumn sampling, possibly reflects more difficult feeding conditions.

The majority of foreguts (68%) contained, in addition to identifiable food material, fine material referred to as particulate matter. This consisted of the indigestible residue from various food organisms, mud and sand, all probably from the alimentary tracts of animals preyed upon, together with some partly digested organic matter which was too macerated to permit identification with any particular animal group. The possibility that algae were also included in this residue cannot be excluded.

DISCUSSION

The object in determining the food of any animal is ultimately to relate this to its growth and food competitors. The relationship between identified stomach contents and nourishment is more difficult in an animal like the Norway lobster which masticates its food before ingestion within the foregut, which is itself the site of further mastication and of the greater part of the digestive processes. This latter characteristic accounts for the difficulty in identifying food organisms and inevitably results in a bias appearing in the results in favour of shelled forms such as crustacea, molluscs and echinoderms, as compared with polychaetes. Moreover some food, e.g. algae, may not be recognisable in normal analyses.

The Norway lobster is caught only on a very precise substrate consisting of sticky mud. This limitation of the substrate results in a uniformity of the community of animals available as food and is reflected in the uniformity of the foregut contents. Whilst, in general, the Norway lobster forages for food, taking indiscriminately those organisms which it encounters, either on or just within the bottom, it could well be that some categories of food, such as hydroids, which are not commonly found amongst the foregut contents, are only resorted to when other food is scarce. This may particularly apply to food which is obtained by grazing off small stones or shells. Although in general the Norway lobster is non-selective, a recent settlement of larvae, resulting in a dense population of one type of food, may to some extent give the appearance of a preference for this type to a variety of other organisms.

Fishermen report that Norway lobsters are caught in much greater numbers around dawn and dusk. Presumably this is the period when the Norway lobsters are foraging for food most intensively. At other times a proportion of the stock will not be feeding and will therefore be less easily caught because they have retreated into hollows. Judging by the behaviour of the animal when kept in aquaria, it seems possible that these non-foraging animals will remain at the entrance to their retreat with their great claws protruding. It may be that in this position they are suitably placed to grab active food which is passing. These Norway lobsters, which will be caught only with difficulty, might well reveal a different type of diet from foraging animals.

Around Scotland few female Norway lobsters are caught from October to April, when the mature adults are carrying spawn. It is not possible to say what food, if any, these berried females may be taking. The fact that they are seldom caught in the trawl suggests that they do not forage over the mud. That being so, if they are feeding, the composition of their food could differ considerably from that of Norway lobsters which are taken by the trawl.

The stomachs of Norway lobsters frequently contain small forms, particularly larval and early post-larval specimens. These represent a considerable part of the diet of the animal and underline the importance to the Norway lobster of summer feeding covering the period of larval settlement and early growth of food organisms. Available food will vary seasonally and the foregut contents will necessarily reflect these seasonal variations.

Despite the above limitations the foraging Norway lobster will reflect the main feeding of the species and the foregut contents of these forms will reflect the main food of the animal.

SUMMARY

1. The foregut contents of male and female Norway lobsters, of various size groups and from five different areas, are analysed.

2. The Norway lobster handles food particles with its walking legs and masticating appendages. This sets a minimum size limit for available food organisms of the order of 1 mm.

3. Polychaetes, crustaceans and molluscs are eaten in roughly equal numbers. Echinoderms, although less common, are generally eaten.

4. A high proportion of foreguts contain three or more food types.

5. The types and species of food organism in all five areas and at all seasons are markedly uniform.

6. The Norway lobster is, in general, a varied feeder regardless of sex or size and takes indiscriminately the available food organisms occurring either on or just within the sea bottom.

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